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HISTORY OF THE MK 58 WARHEAD (U)
SC-M-68-50

Weapon Systems

SC-M-68-50 39

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Redacted Version

Information Research Division, 3434

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Mk 58 Mod 1 - Cross Section

Timetable of Mk 58 Events

Mid-1959	Development of concern over enemy defenses to ballistic missile attacks. Cluster warheads proposed.
8/59	Study of cluster warheads completed, and design recommended.
11/24/59	Director of Defense Research and Engineering requests Atomic Energy Commission to participate in feasibility study of a cluster warhead for the POLARIS missile.
1/22/60	Feasibility study report recommends development of thermonuclear cluster warhead for POLARIS.
7/60	Decision made that both air-burst and surface-burst fuzing be provided.
7/19/60	Director of Defense Research and Engineering requests United States Atomic Energy Commission to design POLARIS warhead. Nuclear portion of project assigned to Lawrence Radiation Laboratory.
8/16/60	Military characteristics for POLARIS warhead approved by Military Liaison Committee.
10/60	Nomenclature of XW-58 assigned to warhead.
1/25/61	Sandia and Lawrence Radiation Laboratory forward development program definition of XW-58 Warhead to Albuquerque Operations Office.
8/8/61	Report SC4830(WD), XW-58 Warhead Proposed Ordnance Characteristics, reviewed by Navy and accepted.

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11/6/62	Mk 58 Warhead program authorized for production.
5/16/63	Mk 58 Mod 0 Warhead design released.

6/27/63	Report SC4860(WD), Mk 58 Mod 0 Interim Development Report, reviewed by Navy and accepted, pending further tests.
	(b)(1), (b)(3)
3/19/64	Early production of Mk 58 Mod 1 Warheads.
9/2/64	Report SCL-WD-64-18, Mk 58 Mod 1 Warhead Final Development Report, accepted by Field Command.
10/7/64	POLARIS missiles, equipped with Mk 58 Warheads, arrive on station.
12/6/65	Navy requests additional warhead protection against high-energy X-rays. Mod 2 proposed, but not authorized.

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Preliminary design suggested that the three re-entry bodies be mounted on a support structure and an ejection system be provided to disperse the rocket-propelled re-entry bodies at an altitude of about 200,000 feet on the exit phase of the missile trajectory. An ejectable fairing would cover the three re-entry bodies during underwater launch of the POLARIS A-3 missile and throughout early flight phase.

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Two basic configurations were being considered for the re-entry bodies. Both had the same cylinder and flare, but differed in nose shape. A hemispherical nose shape would be made of pyrolytic graphite material, and an elliptical nose shape would be made of either pyrolytic graphite or beryllium. Either design would result in a maximum inner wall temperature of 1500°F, and insulation between the inner wall and the warhead would limit the temperature of the latter to not more than 300°F.[7] The hemispherical shape was eventually chosen.

By July 1960 a decision had been made that both air-burst and surface burst fuzing would be provided. (b)(3) The air-burst fuze would be an inertial type consisting of a range-corrected timer started by decelerometer. The air-burst fuze would be effective against about 95 percent of the targets proposed for the POLARIS weapon system. The remaining 5 percent would be located at too high an altitude, and would be attacked with the surface-burst fuze. A means would be provided for selecting surface burst for any target.

The primary safety component was the decelerometer. This would be an integrating type requiring a deceleration of 10 g's for 5 seconds before permitting arming. An integrating accelerometer would function as a complementary safety device for added safety during handling and to isolate electrical circuits entering the re-entry body. An interlock assembly and a pulse-type pullaway connector would prevent arming in the event the missile was off course or re-entry body/missile separation was not achieved. A thermal battery initiated by re-entry heat would supply power.[8]

The Director of Defense Research and Engineering, in a letter dated July 19, 1960, requested the United States Atomic Energy Commission to proceed with design of the POLARIS Warhead.[9]

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It was noted that the Lawrence work load was quite heavy, and that no new development programs should be assigned to this laboratory in fiscal 1961 without compensatory reduction in other programs. However, since the operational availability date of the POLARIS Warhead called for a 4-year development cycle, rather than the 3 years specified in the warhead feasibility study, it was felt that adjustments to other weapons programs might not have to be made.[10]

The military characteristics for a POLARIS Warhead were approved by the Military Liaison Committee August 16, 1960. Three similar warheads would be used in each missile assembly.

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The Department of Defense was responsible for the weapon, exclusive of the warhead, and had designated the Bureau of Naval Weapons as the cognizant agency for development of the POLARIS system. The Lockheed Missile and Space Division was missile system manager and was responsible for re-entry body system, missile assembly, support equipment, and testing. The Naval Ordnance Laboratory would provide an integrated fuzing and firing system.

The flight-test program would encompass 14 tests, which would start in October 1962. Pilot release was being planned for December 1962 with complete design release by March 1963. Early production had been accelerated to January 1964 and operational availability with a POLARIS submarine complement of 48 warheads by June 1964.

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The integrated fuzing and firing system would be a Military responsibility and would provide air-burst fuzing, controlled by a barometric switch, having three burst-height options and surface burst. Environmental sensing devices would prevent system operation until all environments associated with a normal launch and re-entry trajectory had been experienced.

The firing system would contain an explosive-electric transducer, and the warhead would be sealed, either as an entity or as an integral part of the warhead/nose-cone assembly. The boosting-gas reservoir would be installed in a well and would allow replacement without breaking the warhead seal. The warhead would be attached to the re-entry system structure by a flange near the aft end of the warhead.

The POLARIS A-3 missile had a maximum diameter of 54 inches, length of 31 feet, launch weight of 35,000 pounds, and a range from 500 to 2500 nautical miles. The missile

in coordination with Navy representatives. The review established that the design met all requirements of the approved military characteristics and all other known operational, logistic and safety requirements of the Department of Defense. The design was acceptable to the Military.[18]

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Measures were being taken to limit the effects of countermeasures on the warhead.

The individual re-entry bodies were being designed with a maximum flare diameter of 23.5 inches, length of 54 inches, and weight of 300 pounds. Each contained a nuclear system and an integrated fuzing and firing system, surrounded by an outer heat shield. This heat shield had been changed in September 1961 from a pyrolytic graphite design to an ablative heat shield integral with the warhead structure.[19]

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This redesign resulted in a delay in laboratory and flight tests, and caused the design-release date to slip about 3 months. The early production date of January 1964 was not expected to be affected.[21]

The Director of Defense Research and Engineering notified the United States Atomic Energy Commission February 20, 1963, that the Navy was considering a high-yield, semihardened warhead for POLARIS, and a feasibility study was requested.[28] The Division of Military Application subsequently noted that since the warhead characteristics were similar to those of the warhead being developed for the MINUTEMAN missile, the program should be assigned to Los Alamos.[29]

The Mk 58 Mod 0 Warhead was design released May 16, 1963, with the exception of re-entry body shell assembly, cover and primary. System release was completed by July 1963.[30,31]

Field Command notified Sandia-Livermore June 27, 1963 that Report SC4860(WD), Mk 58 Mod 0 Interim Development Report, had been reviewed by the Navy. The design met most requirements of the approved military characteristics. Insufficient data were available to make an evaluation of the capability of the explosive actuator to meet vulnerability requirements. Otherwise, the design met the known operational, logistic and safety requirements of the Department of Defense, but Sandia was requested to ensure that the actuator satisfied vulnerability requirements.[32,33]

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Report SCL-WD-64-18, Mk 58 Mod 1 Warhead Final Development Report, was accepted by Field Command September 2, 1964.

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Air-burst fuzing was

provided, with choice of three heights, as well as an electronic surface-burst fuze that could be used either as primary option or as backup.

The POLARIS missile had a maximum diameter of 54 inches, length of 32.32 feet, launch weight of 35,000 pounds, and a range from 500 to 2500 nautical miles. The missile was a two-stage solid-propellant rocket, with a spin-separation rocket on each re-entry body, and could be launched from either submerged or surfaced submarines. One of three height-of-burst options (timer fire) or a surface-burst option (proximity fuze) could be selected before launch and stored in the missile programmer. At launch an accelerometer enabled the warhead circuits.

Underwater launches could be made at depths up to 100 feet. The missile was ejected from the launch tube by either compressed air or a solid-propellant/steam-launch system. After the missile emerged from the water, the first stage was ignited. First-stage acceleration caused an accelerometer to operate, closing contacts which connected warhead circuitry to thermal battery and missile programmer. This accelerometer operation occurred about 55 seconds after launch, at an altitude of about 62,000 feet.

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The Bureau of Naval Weapons notified Sandia-Livermore, October 7, 1964, that POLARIS missiles were now on station, aboard the nuclear-powered submarine USS Daniel Webster. This significant milestone of a truly global deterrent was hailed as a source of pride to everyone, military and civilian, who had taken part in the nationwide POLARIS team. A heartiest "well-done" was extended to the entire POLARIS group.[38]

A report entitled "Mk 58 Mod 1 Weapon Description" was issued in December 1965. The warhead was defined as a major assembly consisting of nuclear system and electrical circuitry, hardware to hold the parts together, DOD-supplied fuzing and firing device, and DOD-supplied ablative material bonded to the warhead case.

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The entire warhead was enclosed in a magnesium case and an aluminum cover. The warhead ablative heat shield was of nylon phenolic laminate bonded to the magnesium case. The cover incorporated two antenna connectors for the target-detecting device, a baro port which provided atmospheric-pressure information to the baroswitch, and a purging port used in filling the warhead with dry air.

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A single-channel fuzing and firing device was mounted in the warhead compartment. Battery and target-detecting-device antennas were mounted in the re-entry body flare.

Development Program Definition -- A report that describes the weapon to be designed and the steps that will be taken in its development.

Director of Defense Research and Engineering -- Handles research and development activities for the Department of Defense.

Division of Military Application -- An AEC office that functions as liaison between the Military and weapons designers and producers.

Dominic -- A full-scale test operation held in the Pacific. Series of 39 tests, April 25 to November 4, 1962. Dominic was authorized after the test ban was broken by the Soviet Union in 1961.

Environmental Sensing Device -- A device that reacts to a specific environment of the weapon, such as speed, acceleration, altitude, etc.

Field Command -- The local office of the Armed Forces Special Weapons Project (Defense Atomic Support Agency), located on Sandia Base, Albuquerque, New Mexico.

Firing System -- The electrical system of the weapon that produces and applies a high-voltage current to the detonators.

Fuzing System -- The system that arms the weapon at the appropriate time and provides a firing signal to the firing system at the selected burst height.

g -- Force equal to one unit gravity.

Gas Boosting -- The technique of increasing the yield of a nuclear device by introducing deuterium-tritium gas into the implosion process to increase fission activity.

Hardtack -- A nuclear series of 72 tests. Hardtack I was held at the Pacific Proving Grounds from April 28 to August 18, 1958. The decision to declare a moratorium on testing resulted in Hardtack II, held at the Nevada Test Site between September 12 and October 30, 1958.

Kiloton -- A means of measuring the yield of an atomic device by comparing its output with the effect of an explosion of TNT. A 1-kiloton yield is equivalent to the detonation effect of 1000 tons of high explosive.

Lawrence Radiation Laboratory -- A nuclear design organization located at Livermore, California.

Military Characteristics -- The attributes of a weapon that are desired by the Military.

Military Liaison Committee -- A Department of Defense committee established by the Atomic Energy Act to advise and consult with the AEC on all matters relating to military applications of atomic energy.

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One-Point Safety Test -- A test in which the high-explosive sphere is detonated at one detonator or point. If the device is one-point safe, no nuclear yield is produced.

Operation Dominic -- See Dominic.

Operation Hardtack -- See Hardtack.

Operation Nougat -- See Nougat.

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Safing -- Putting a weapon in condition such that it cannot fire.

Secondary -- The thermonuclear portion of a two-stage weapon.

Squib -- A device containing a small explosive charge. When detonated, the resulting gas pressure closes a switch or performs a similar action. A light, quick-acting, one-shot device.

Thermal Battery -- A battery whose electrolyte is in a solid state while inactive. To activate, heat is applied to this electrolyte, melting it and putting the battery into active output condition.

Thermonuclear -- Two-stage reaction, with a fission device exploding and starting a fusion reaction in light elements.

Tritium -- The hydrogen isotope of mass number 3.

Warhead -- A weapon carried to the target by missile.

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